# Retinal oximetry in health and disease

Oxygen is one of the most essential elements, if not the most essential for our lives. We can survive without water and food for days, however, surviving for more than two minutes without oxygen is not possible. Hence it stands to reason that alterations in oxygen saturation would have far reaching effects on tissue function. If we can reliably detect this alteration, we can be certain of some tissue dysfunction. Furthermore, this can not only be used to diagnose disease, but also to monitor response to treatment. If deranged saturations show a trend towards normal, we can safely assume that the tissue function would also return to normal.

Pulse oximetry is measured on the fingers using the principle of photo spectrometry. A point worth considering is that while the fingers are covered with skin and nails which can potentially mask true variation, the retina is easily visible with transparent tissue anterior to it. Thus, it stands to reason that the measurements obtained from the retina can be a more accurate representation of true physiological values. It must be emphasised that the saturation values thus obtained will not only be suggestive of the changes occurring locally in the retina but can also give us information about systemic alterations.

The arguments presented above make a strong case for retinal oximetry, however, this investigation is not yet a part of mainstream clinical investigations. With the advent of multimodal imaging, importance is given to obtaining a comprehensive picture comprising of anatomical and functional information. Retinal oximetry if added to this ensemble can provide crucial information about the metabolic functional giving us a more complete understanding.

So why is retinal oximetry still not mainstream, despite more than 50 years of research? One of the main reasons for this is the presence of unresolved artefacts that render the obtained values less precise and accurate. Through our mathematical modelling we exposed the fact that there were too many variables that were assumed to be constant among individuals. We showed that not only do they have inter-subject variation, but they also have intra-eye variation between different vascular segments. Thus, more wavelengths and better algorithms would be needed to reliably calculate oxygen saturation.

Disease is a dynamic process and taking a static snapshot may not always tell us the complete picture. Oxygen saturation gives the percentage of haemoglobin that is saturated with oxygen; however, it does not tell us what quantity of oxygen has been delivered to the retina. For this information on flow is critical. Machines like the retinal function imager have tried to address this issue by measuring the velocity of blood flow

and the diameter of the vessels. The diameter and velocity will tell us the volume of blood that courses through the retina per unit time and the saturation can tell us what amount of oxygen is being carried per unit volume. When these parameters are combined, we can estimate the amount of oxygen delivered and consumed per unit time. Understanding this parameter can have far reaching implications and can remarkably alter our understanding of disease. Additionally, retinal vascular imaging encompassing anatomical factors like vessel width and fractals and functional parameters like flow and oxygen saturation can be used as important biomarkers for the function of a number of organs ranging from the brain to the heart to the lungs.

While with any technology, we should proceed with caution, we should also be excited about its prospects and the positive impact it could have. Let us imagine the potential of autofocussing retinal cameras with automatic imaging, segmentation, and selection. We can potentially have a fully automatic system in the future that can give the vascular saturations and even a grading of the level of oxygenation to the retina. These can then be set up as kiosks in malls and other public spaces allowing for a rapid screening of the patient's retina. For a retina clinic, this can be additionally combined with dynamic flow volume information. This would form an important aspect of any multimodal imaging protocol and pave the way for a complete anatomical and functional understanding of the patient's retinal status.